# THE WEATHER AND CIRCULATION OF JULY 1961

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## 1. INTRODUCTION

July 1961 was the fourth consecutive month in which temperatures averaged cooler than normal in most of the eastern half of the United States (fig. 1). This cool regime began with a sharp temperature reversal from March to April [1], then gradually intensified through June [2], and was finally modified in July. The warming trend in the West, which progressed from initially cool conditions in April to persistent and locally intense heat in June, was reversed in July. Thus the latter month afforded some relief from heat in the West, along with more favorable growing weather for retarded crops in the Corn Belt.

## 2. MEAN CIRCULATION

The mean 700-mb. circulation for July 1961 (fig. 2) was dominated by blocking and low index conditions, as indicated by the prevalence of positive height anomalies at higher latitudes and negative anomalies at lower latitudes. Blocking was particularly strong in North America and the Pacific, where there were three positive height anomaly centers with departures from normal as much as 200 ft. or more (fig. 2). Also noteworthy was the occurrence of easterly anomalous flow at middle latitudes over much of the Western Hemisphere.

The zonal index, as measured by the net west to east geostrophic flow between latitudes 55° and 35° N. in the western sector of the hemisphere, was 1.1 m.p.s. below normal at both sea level and 700 mb. during July. These are rather large departures for this index during a summer month. It is also of interest that the 5-day mean zonal index routinely computed three times a week, remained continually below normal during the entire month at 700 mb. and during all but one period at sea level. The 700-mb. subtropical westerlies also averaged well below normal (1.3 m.p.s.) for the month as well as during all 5-day periods.

Blocking was related to the displacement of the primary mean 700-mb. jet axis southward from its normal position over much of the hemisphere in July (fig. 3). Greatest displacement was over eastern North America where blocking was strongest. Over northeastern sections of the Atlantic and Pacific northward extension of the subtropical ridges displaced portions of the mean jet northward.

The polar circulation was featured by a deep closed Low surrounded by an almost continuous ring of positive height anomalies (fig. 2). Fast westerlies around this Low were associated with the eastward displacement of most of the normal trough-ridge systems at high latitudes. The ridge normally found near Alaska was flattened and elongated eastward, the Baffin Island Low was shifted eastward to Greenland, and one cell of the Icelandic Low was located in the Norwegian Sea.

Changes of mean 700-mb. height anomaly from June to July (fig. 4) were predominantly positive at high latitudes and negative at low latitudes. Net changes, computed for complete latitude circles at intervals of 5° lat., were strongly positive from 80° to 60° N. and decidedly negative from 50° to 25° N. This indicates an increase in high-latitude blocking from the previous month.

## 3. CIRCULATION AND TEMPERATURE CHANGES DURING JULY

There were two distinct circulation regimes over and near the North American continent in July. During the first 10 days (represented by the 5-day mean for July 4–8, fig. 5A) an active mean trough retrograded into the eastern United States from the Atlantic, while a well-developed mean ridge dominated the region from Texas northward through central Canada. Temperatures at this time (fig. 5B) were well below normal

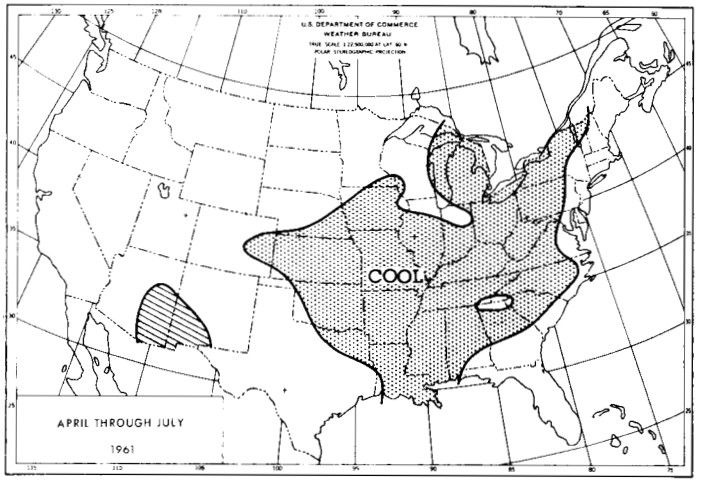



FIGURE 1.—Areas with cooler than normal (stippled) and warmer than normal (hatched) monthly average temperatures for four consecutive months, April through July 1961 (from [5]).

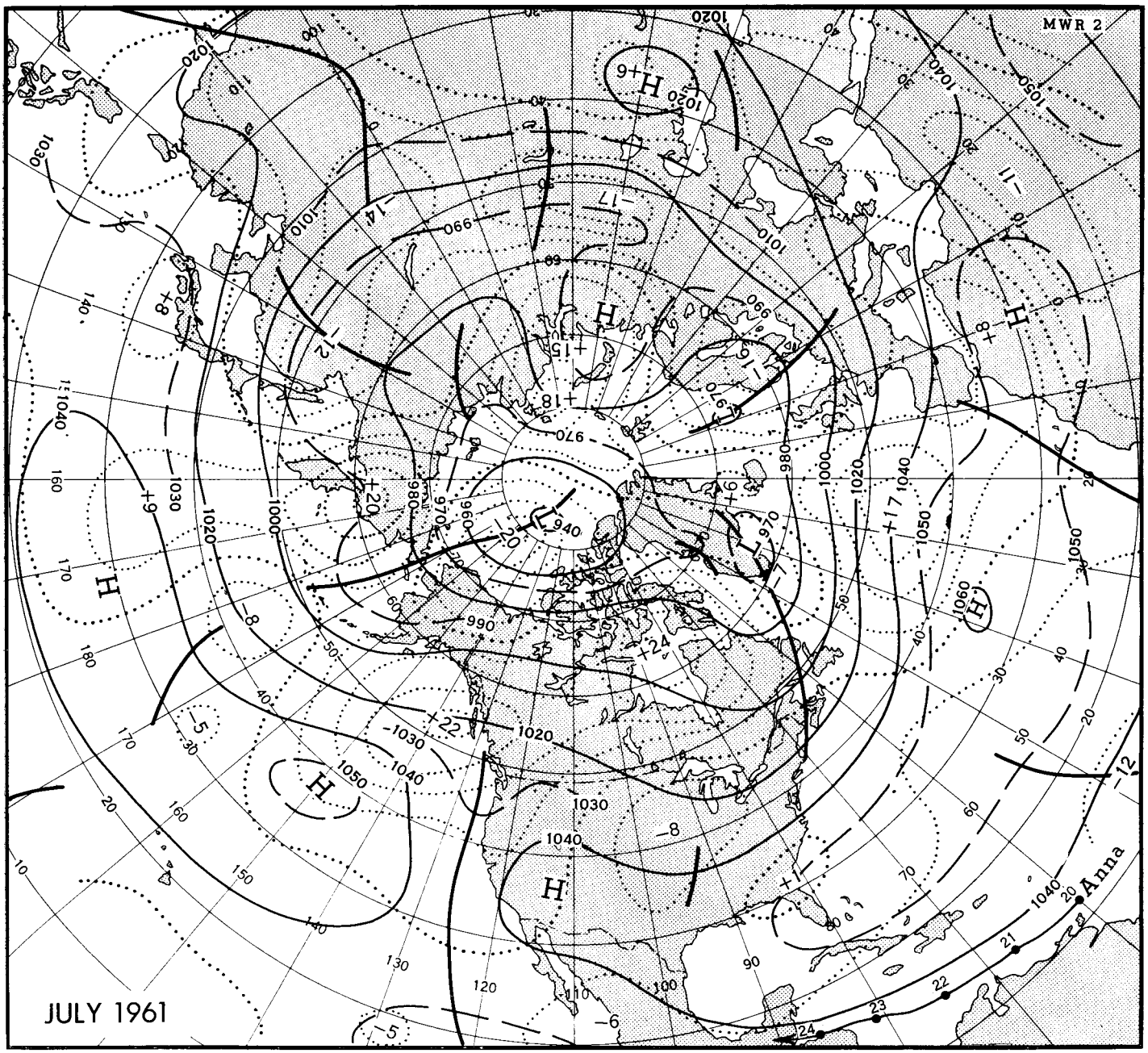



FIGURE 2.— Mean 700-mb. contours (solid with intermediate contours dashed) in tens of feet, and departures from normal (dotted) in 50-ft. intervals for July 1961. High-latitude troughs and ridges around the periphery of the deep polar Low were displaced eastward from normal positions. Height anomaly patterns characteristic of blocking were prevalent over much of the hemisphere. Also depicted is the path of hurricane Anna. Large dots and dates indicate 0000 GMT position of storm.

over the eastern half of the country in response to northerly flow from Canada into the vigorous mean trough. Warm temperatures prevailed over the northern Rockies and the northern Plains beneath the mean ridge. Subnormal temperatures in the Southwest were associated with a fairly vigorous mean trough along the west coast, and with the onset of summer showers.

Subsequently, the mean ridge in the eastern Pacific began to grow, a trough developed from the Great Lakes southwestward, and the eastern trough returned rapidly to the Atlantic. The resulting regime (fig. 6A) remained relatively unchanged during the last two-thirds of the month.

During this reversal of circulation the eastern trough was replaced by a ridge and the western ridge by a trough. The parallel reversal of surface temperature produced a remarkable contrast between temperature anomaly patterns of the weeks ending July 9 (fig. 5B) and July 23 (fig. 6B). Weekly average anomalies from the first week to the third warmed as much as 9° F. over the eastern Great Lakes and parts of California and cooled more than 6° F. in the northern Plains.

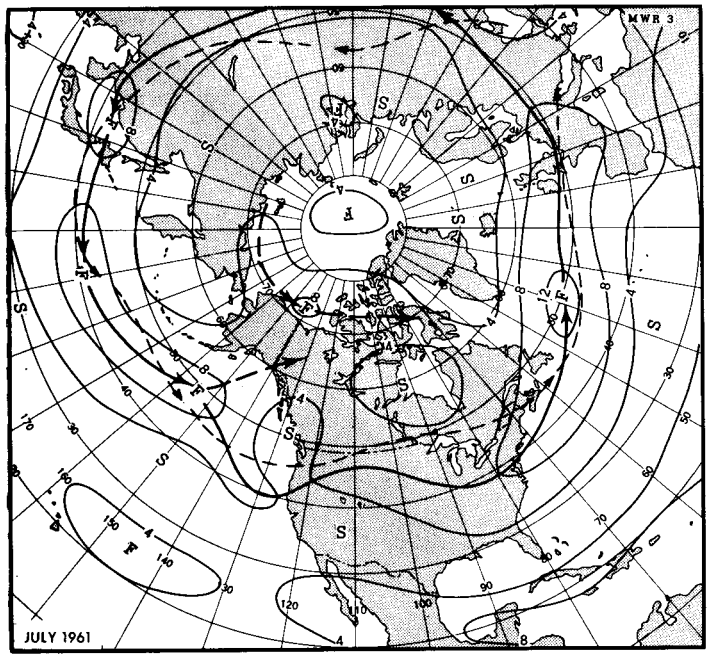



FIGURE 3.—Mean 700-mb. isotachs for July 1961. Heavy solid arrows indicate primary axes of the mean maximum winds; heavy dashed arrows secondary axes; and light dashed arrows, their normal July positions. Primary axes were generally south of normal over the continents but displaced northward by strong subtropical ridges in northeastern sections of both oceans.

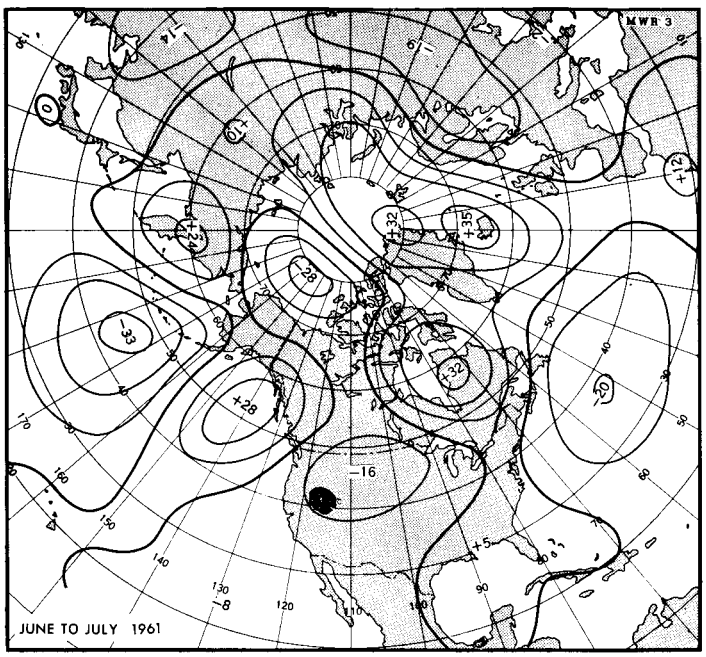
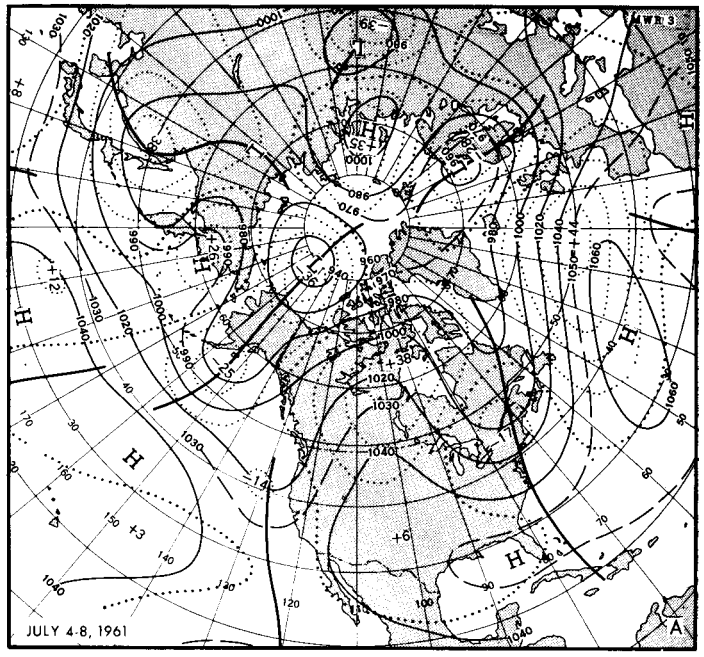



FIGURE 4.—Change in 700-mb. height anomaly (tens of feet) from June to July 1961. Positive changes were predominant at higher latitudes.



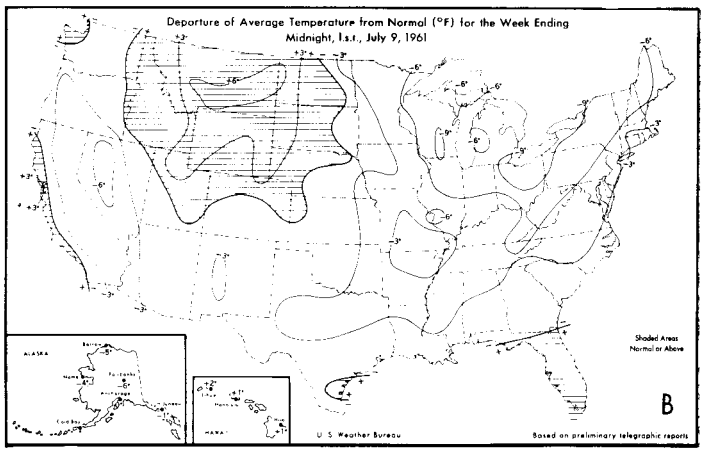
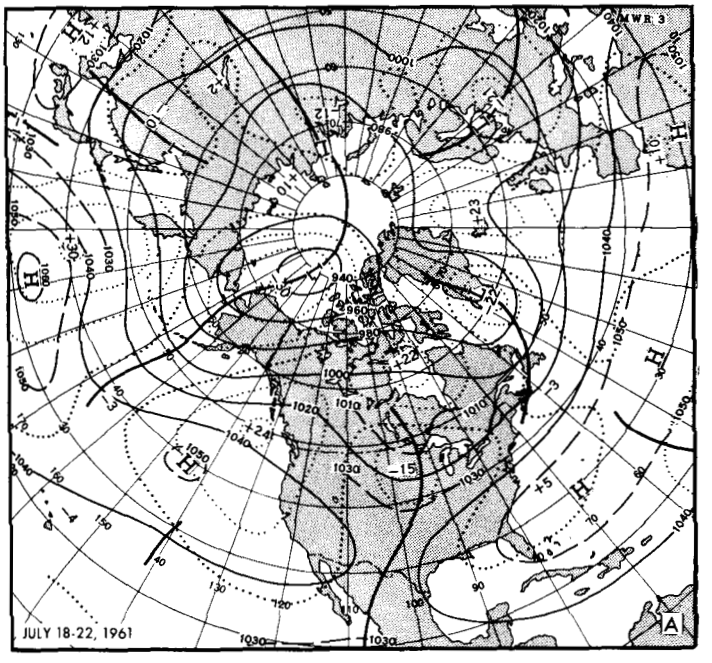




FIGURE 5.—(A) Five-day mean 700-mb. contours and departures from normal (both in tens of feet) for July 4–8, 1961. (B) Departure of average surface temperature (°F.) from normal for the week ending July 9, 1961 (from [5]). These patterns were typical of the first 10 days of the month.

## 4. AVERAGE TEMPERATURE FOR THE MONTH

The contrast of intra-monthly patterns of temperature departure tended to lessen the likelihood for extremes in the monthly pattern (fig. 7). However, new low marks for the monthly average were established at Baton Rouge and Shreveport, La., and at Midland, Tex.

Temperature changes from June to July were closely related to changes in the mean circulation of the mid-troposphere (fig. 4) over North America. Negative changes of 700-mb. height anomaly were generally coincident with cooling over western United States, while positive changes attended warming. There were no changes of month-to-month temperature class from one



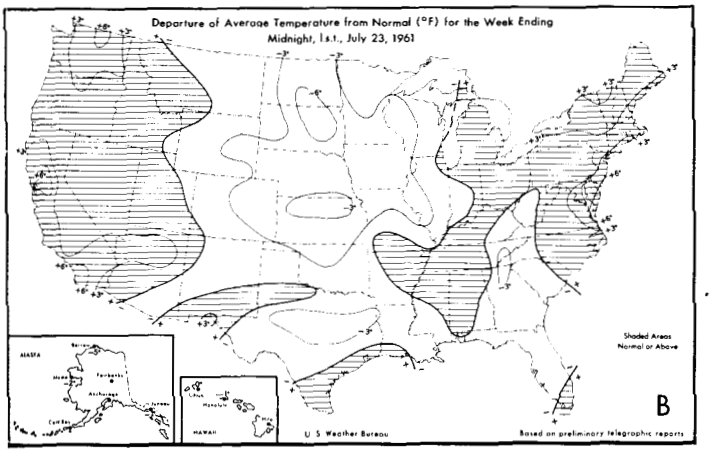




FIGURE 6.—(A) Five-day mean 700-mb. contours and departures from normal (both in tens of feet) for July 18–22, 1961. (B) Departure of average surface temperature (°F.) from normal for the week ending July 23, 1961 (from [5]). These are representative of typical patterns during the last 20 days of the month.

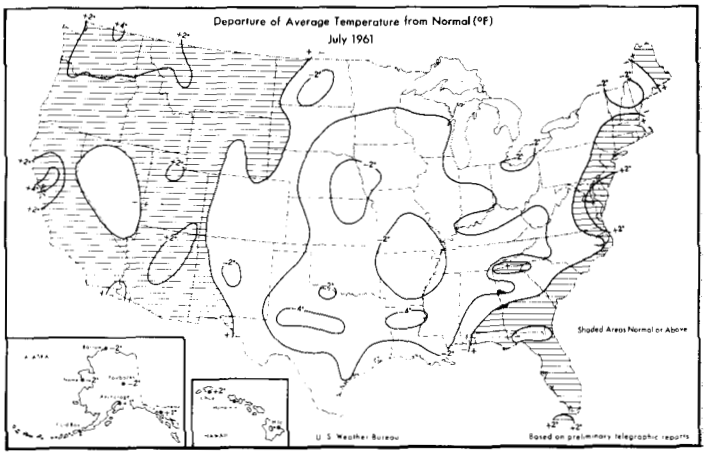



FIGURE 7.—Departure of average temperature from normal (°F.) for July 1961 (from [5]). Greatest departures occurred in Texas and Louisiana (negative) and in California and Washington (positive).

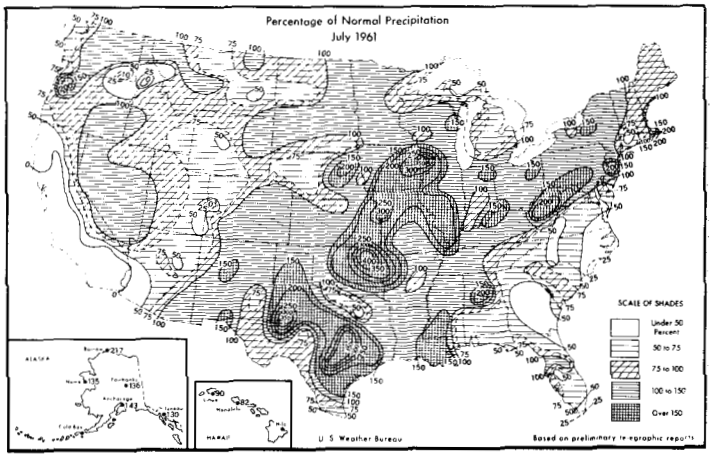



FIGURE 8.—Percentage of normal precipitation for July 1961 (from [5]). Precipitation was especially heavy over much of the southern Plains and the middle Mississippi Valley.

extreme to the other (4-class change). Of 100 representative stations, 72 did not change by more than one class; about the normal degree of persistence for this time of year. Forty-eight stations were cooler while 22 were warmer by one class or more from June to July. The larger number in the cooler category is partly attributable to increased blocking activity from the previous month.

## 5. PRECIPITATION

Some features of the distribution of precipitation in July (fig. 8) can be explained in relation to the mean circulation. For instance, the belt of abnormal amounts extending from Texas to the Great Lakes was related to the cyclonic vorticity observed in this area, where the normal July circulation is strongly anticyclonic. Although the mean trough in the monthly 700-mb. chart of figure 2 appears weak, its significance is substantiated by the negative height anomalies attending it. Most of this precipitation occurred after the initial circulation regime which ended around the 10th, though large amounts had fallen in southeastern Texas early in the month. Some of the heaviest rain occurred along the zone of maximum frontal activity to the north (fig. 9) Heavy rain associated with frontal activity on the 1st resulted in new records for a 24-hr. amount (6.28 in.) and for July (12.23 in.) at Dubuque, Iowa. A squall line was at least one of the factors leading to development of showers on the 19th which deposited 2.92 in. of rain in an hour and 5.60 in. in 24 hr. at Charleston, W. Va. A new record total for July and any month, 13.54 in. was also established there. Other stations reporting the wettest July were Tulsa, Okla., and Midland, Tex.

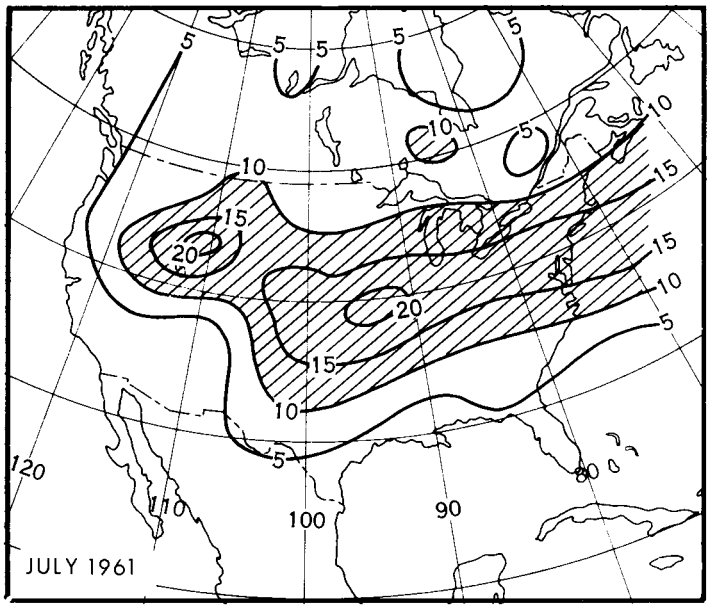



FIGURE 9.—Number of days with fronts in equal-area (66,000 n.mi.²) quadrilaterals for July 1961. The region with 10 or more days with fronts is hatched. Precipitation (fig. 8) exceeded normal in most of the hatched area east of the Continental Divide.

Seasonal rains began in Arizona about on schedule [3] early in the month, ended after a short period, then set in again around the 13th and continued intermittently thereafter. These showers were associated with the injection of moisture from the Gulf of Mexico, induced by normal seasonal evolution of the mean circulation. Nevada and Utah also received appreciable amounts of rain from this source.

Drought continued in the northern Plains, becoming even more severe in some areas. Local showers brought relief in other sections but came too late to do much good. The Southeast was also dry, being under the influence of strong anticyclonic vorticity at both sea level and aloft. Several stations in Florida, including Apalachicola, Lakeland, and West Palm Beach, had record low precipitation totals for the month. Deficits from normal July amounts ranged from 3 to more than 6 inches along the Atlantic coast from Georgia to southern Virginia.

## 6. TROPICAL STORMS

Hurricane Anna developed southeast of the Windward Islands on the 19th in an easterly wave (see track, fig. 2). Its path and rate of travel were remarkably similar to those of hurricane Abby in July 1960 [4]. Anna moved from the vicinity of the Windward Islands to Central America in approximately 4 days along a track just south of the 10,400-ft. contour (fig. 2).

Four storms were reported in the eastern Pacific, southwestward from central Mexico. Two of them reached hurricane intensity.

In the western Pacific there were five storms, of which three developed into typhoons. One of these traveled northward into Korea from the central section of the Philippine Sea, another hovered around the southern tip of Formosa, and the third dissipated in the East China Sea after a rather long northwestward trajectory from its origin near Iwo Jima.

One of the two storms which failed to develop to typhoon intensity originated east of Luzon, traversed that island, then moved westward into the Chinese mainland. The other traversed a short path which was confined entirely to the East China Sea.

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